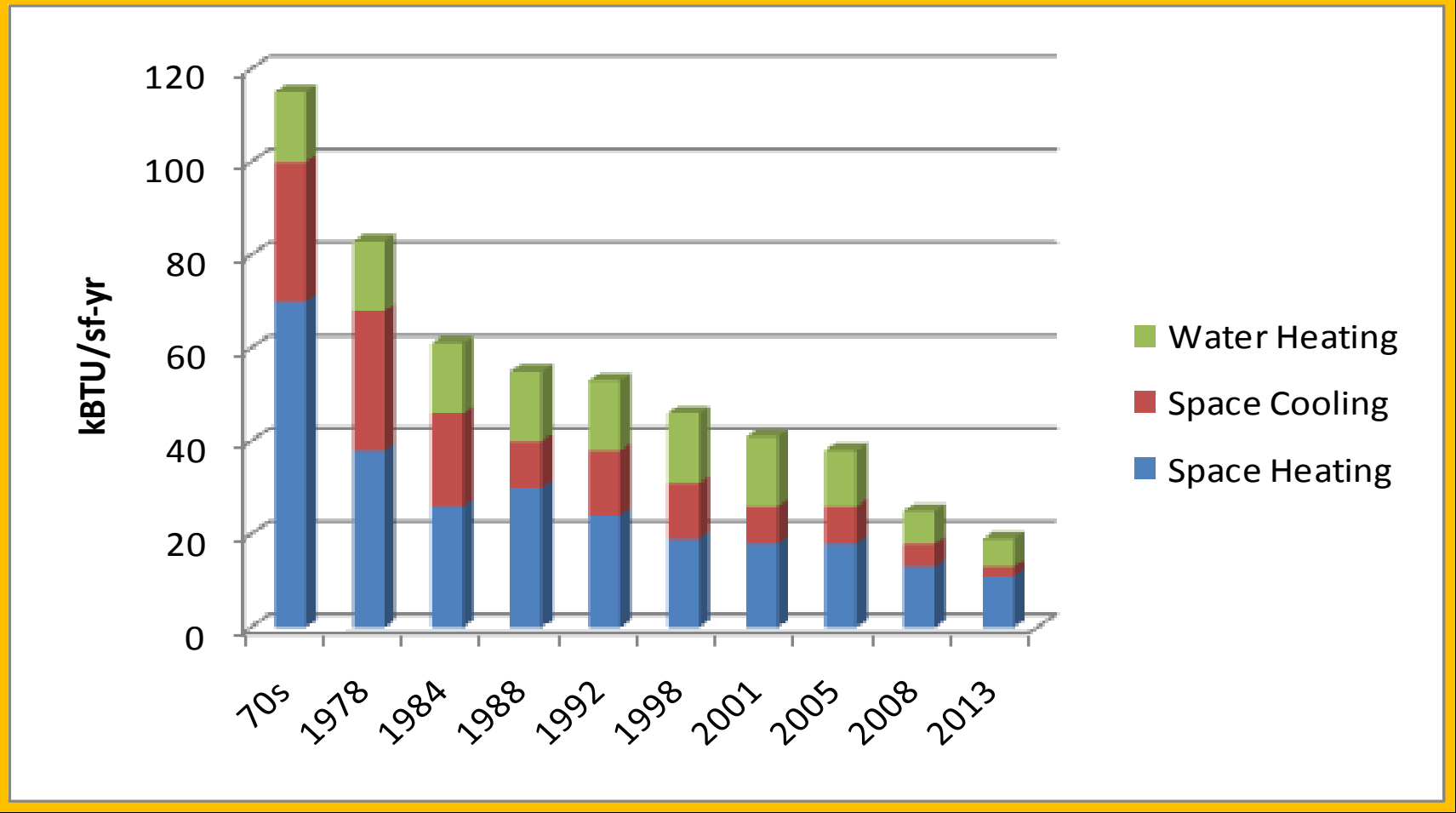
Ducts in Conditioned Space

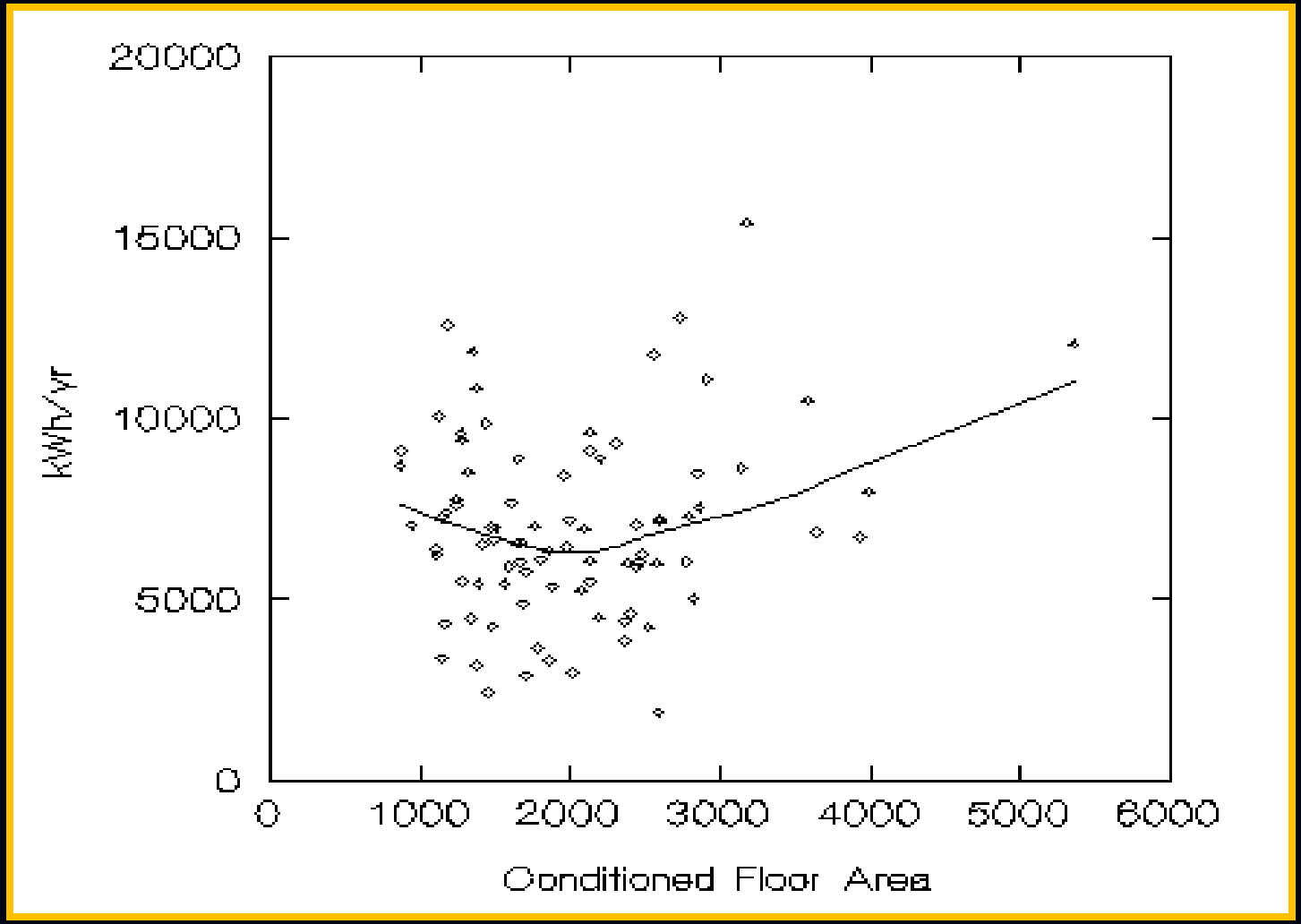
Rick Chitwood
Chitwood Energy Management, Inc.
rick@chitwoodenergy.com

Modeled energy use for each Standards update Northern CA Inland Climate



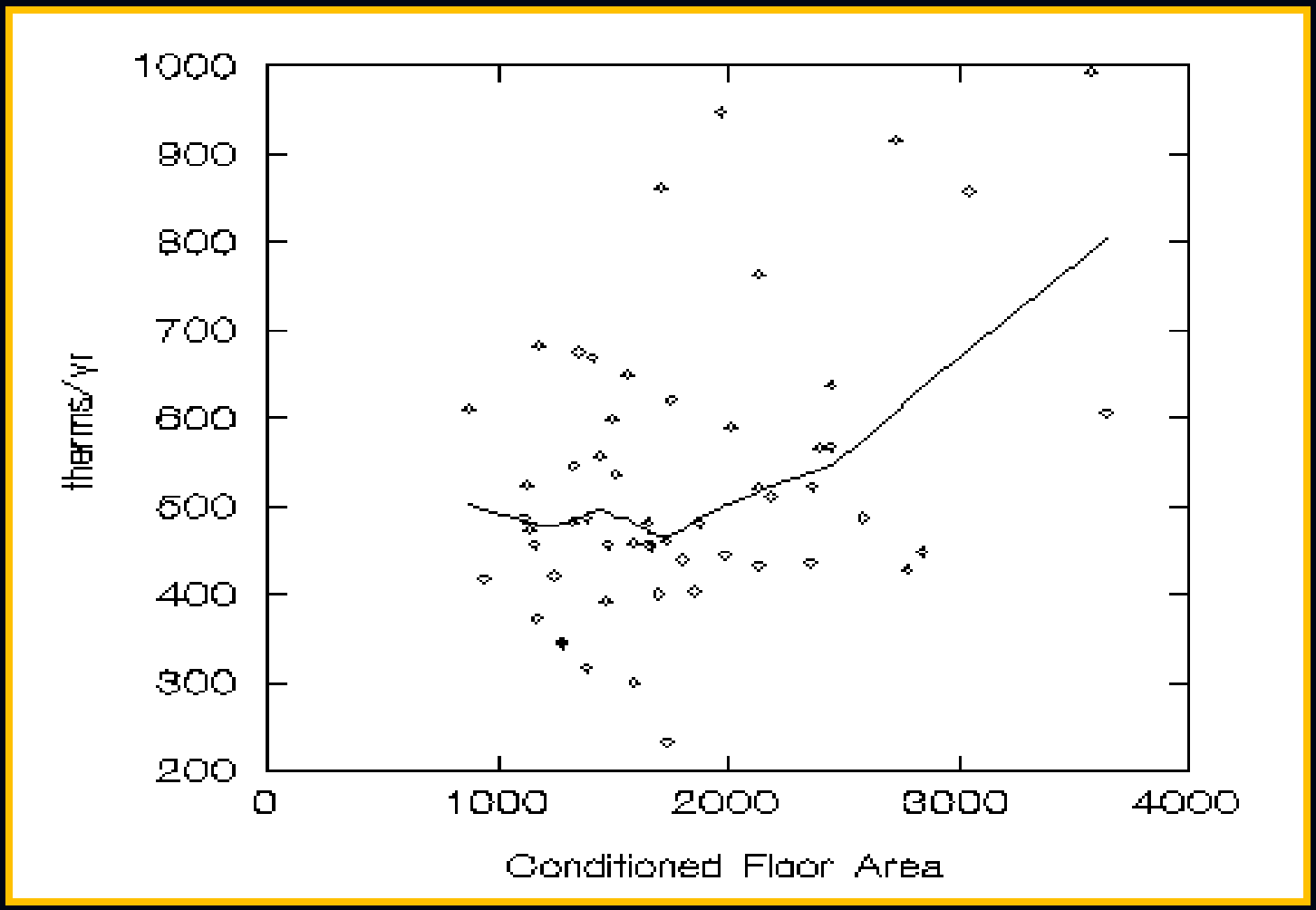
Source: California Energy Commission

How Much Electricity Does A New California Home Use?



Source: California DSM Measurement Advisory Committee report

How Much Natural Gas Does A New California Home Use?



Source: California DSM Measurement Advisory Committee report

Comfort? … in a 2014 home

Source: PG&E ET Project field observation

Comfort? ... in a two story zoned home

Start Test: (Lower Floor Only Calling)

Lower Floor Thermostat	68°F
Upper Floor Thermostat	69°F
Upper Floor Ceiling	68.4°F

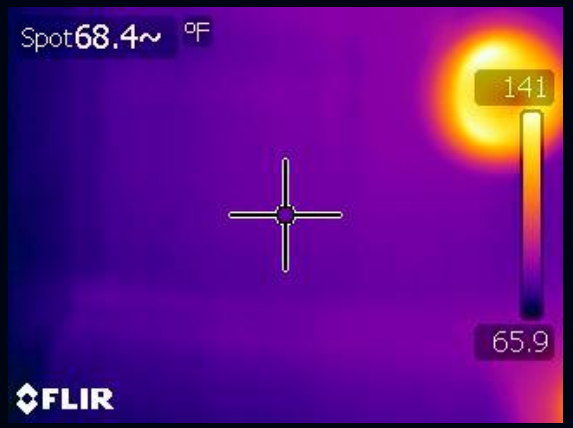
At 15 Minutes: (Lower Floor Only Calling)

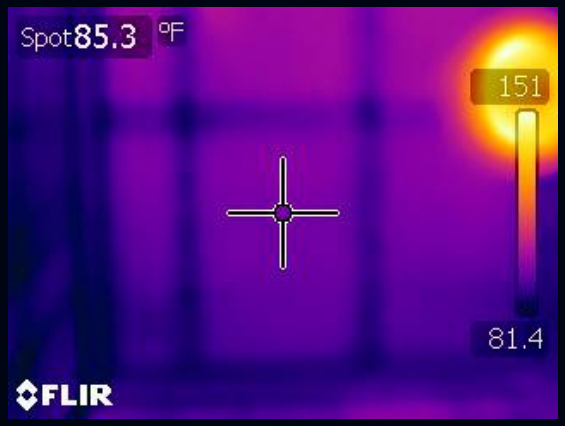
Lower Floor Thermostat	68°F
Upper Floor Thermostat	69°F
Upper Floor Ceiling	85.3°F

Test Ended at 53 Minutes:

Lower Floor Thermostat	72°F
Upper Floor Closet	92.5°F

Source: PG&E ET Project field observation





Current Residential HVAC Design and Installation

	Low	High	% difference
Fan: watts/square foot	**0.13 W/SF**	**0.92 W/SF**	**708%**
Heating: Btu/square foot	**9 Btu/SF**	**110 Btu/SF**	**1,222%**
Cooling: square feet/ton	**1,739 SF/ton**	**200 SF/ton**	**869%**
Air Infiltration: ACH_{50}	**2.40 ACH_{50}**	**38.0 ACH_{50}**	**1,600%**

Note: Average air infiltration is 0.25 ACH in new homes (2010 research, Wilcox, Proctor, Chitwood)

Source: California Energy Commission report 500-2012-062

Where is there HVAC opportunity?

Duct Leakage	7%
Duct Conductive Losses	12%
Refrigerant Charge	8%
Low Air Flow (high latent removal)	14%
Equipment Oversizing	4%
Room Air Delivery and Mixing	5%
Total Performance Opportunity	50%

Four Typical Methods To Get Ducts in Conditioned Space

1. Cathedralized Attic
2. Attic Chases
3. Plenum Trusses
4. Lowered Hallway Ceiling

Cathedralized Attic (with SPF)

Cathedralized Attic (with SPF)

- Tests well
  - Low air infiltration
  - Low duct leakage to the outside
- More immune to installation defects
- Larger surface area to insulate
- Higher insulation costs
- Can use other insulation materials

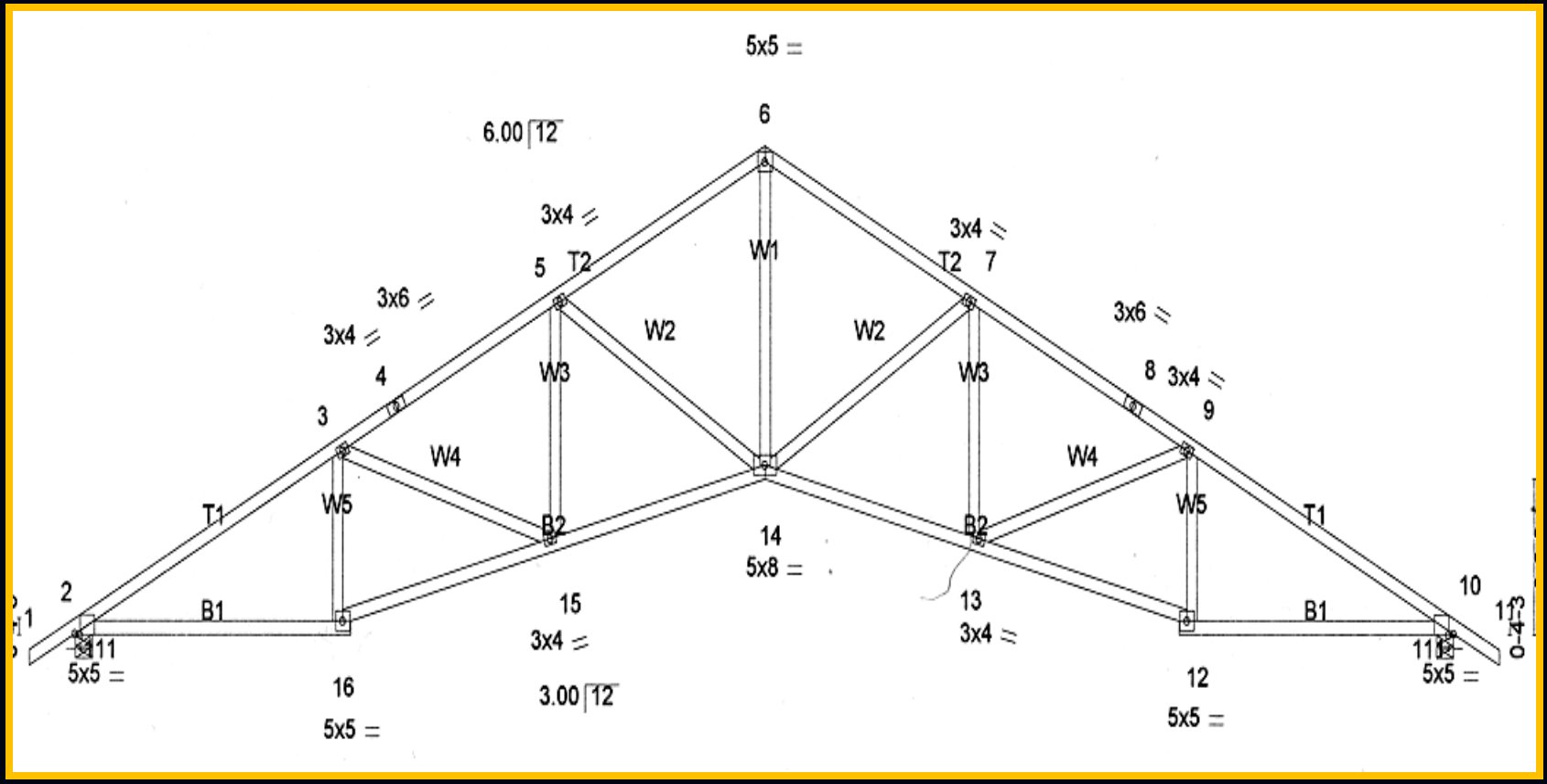
Attic Duct Chases

Attic Duct Chases

- Has not tested well
  - Average amount of air infiltration
  - Does not always pass duct leakage to the outside test
- Prone to installation defects
- Requires lots of worker supervision
- Can impede ceiling insulation installation
- Higher costs

Plenum Trusses

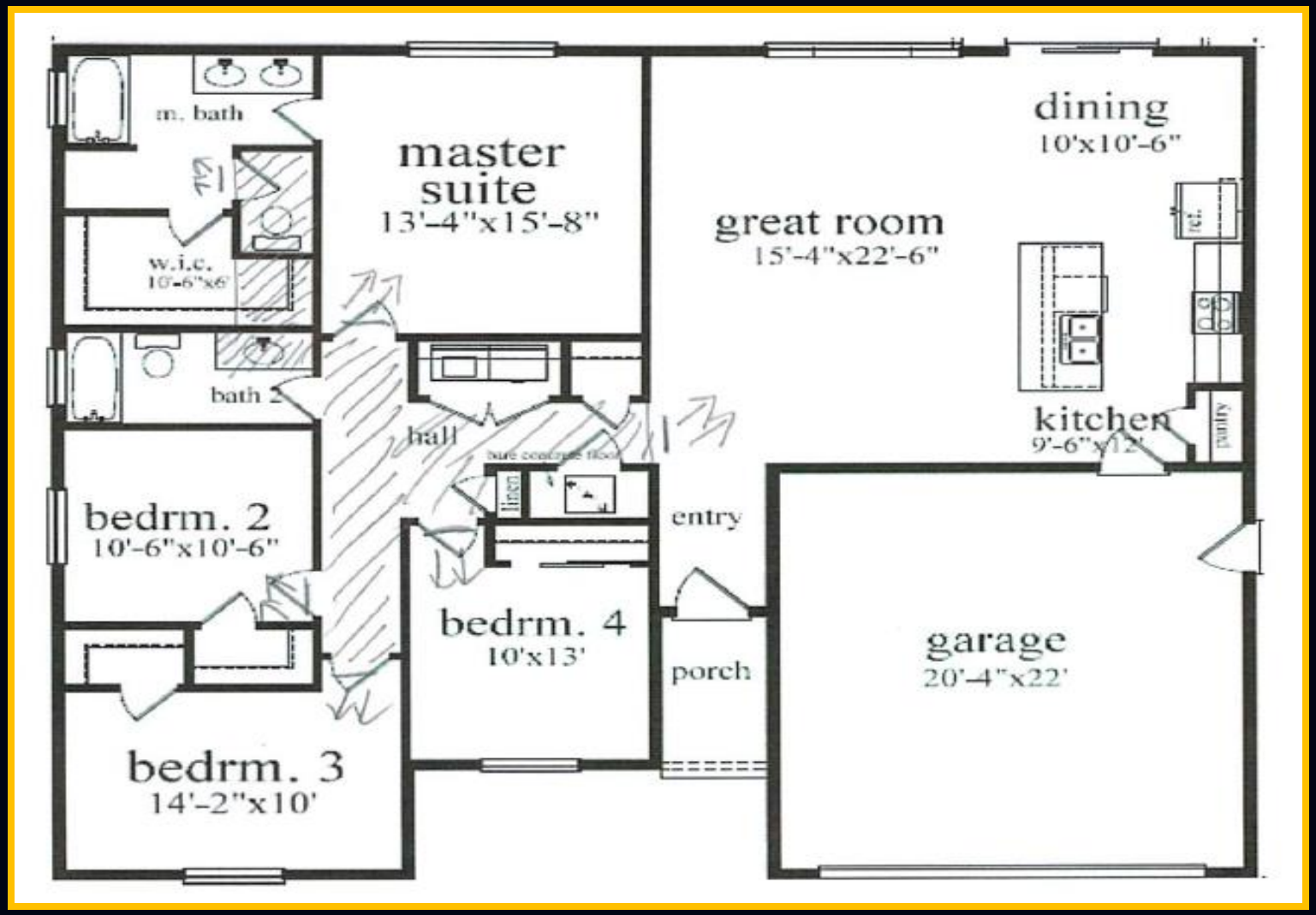
Plenum Trusses



Plenum Truss

- No large scale builder is using this method that we know of
- Has potential
- More immune to installation defects
- Requires good supply grille selection

Lowered Hallway Ceiling

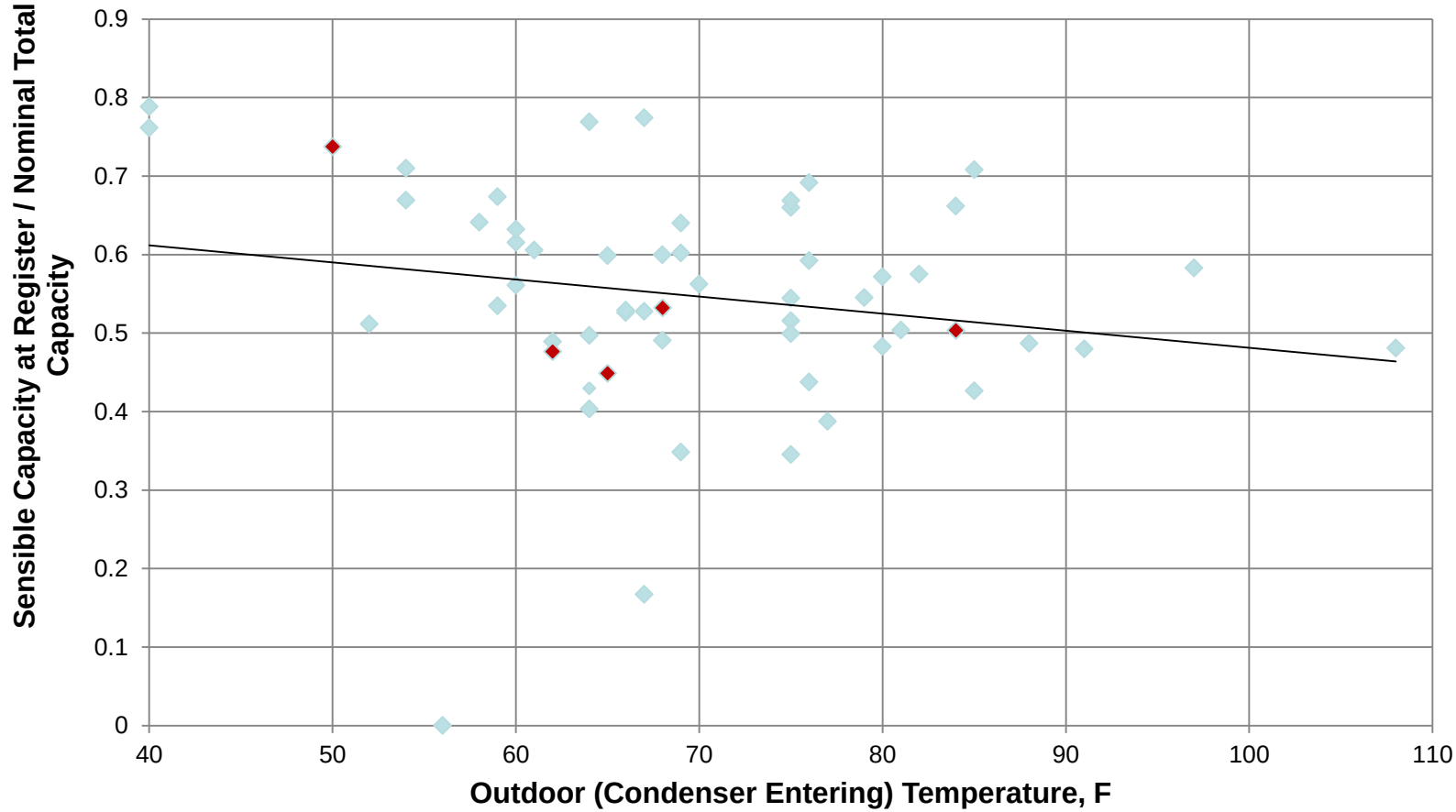


Lowered Hallway Ceiling

- No large scale builder is using this method that we know of
- Has the most potential
- More immune to installation defects
- Least expensive – comparable to current ducts in the attic systems
- Requires good supply grille selection

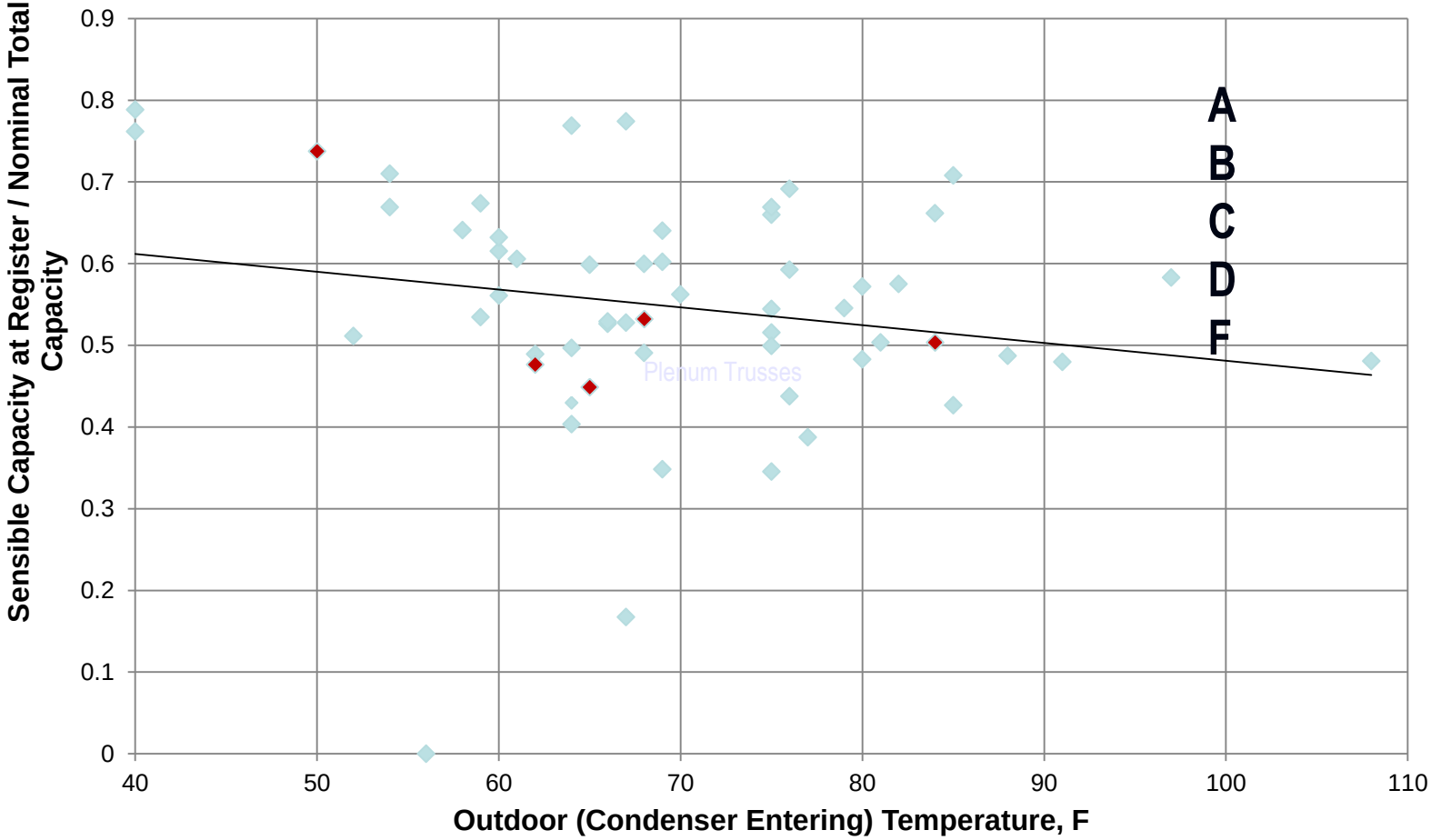
The Data

AC Sensible Capacity



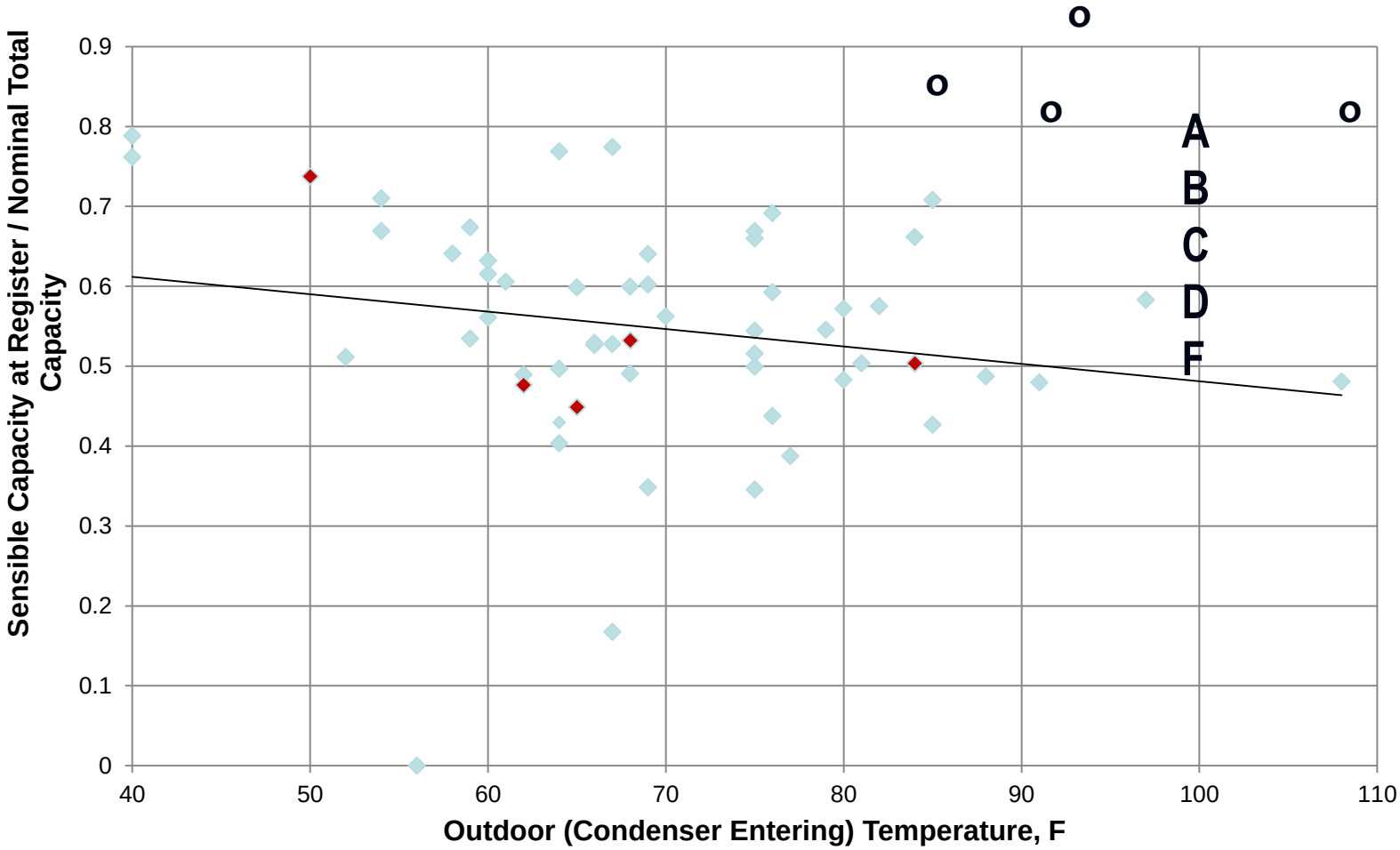
Source: California Energy Commission report 500-2012-062

AC Sensible Capacity



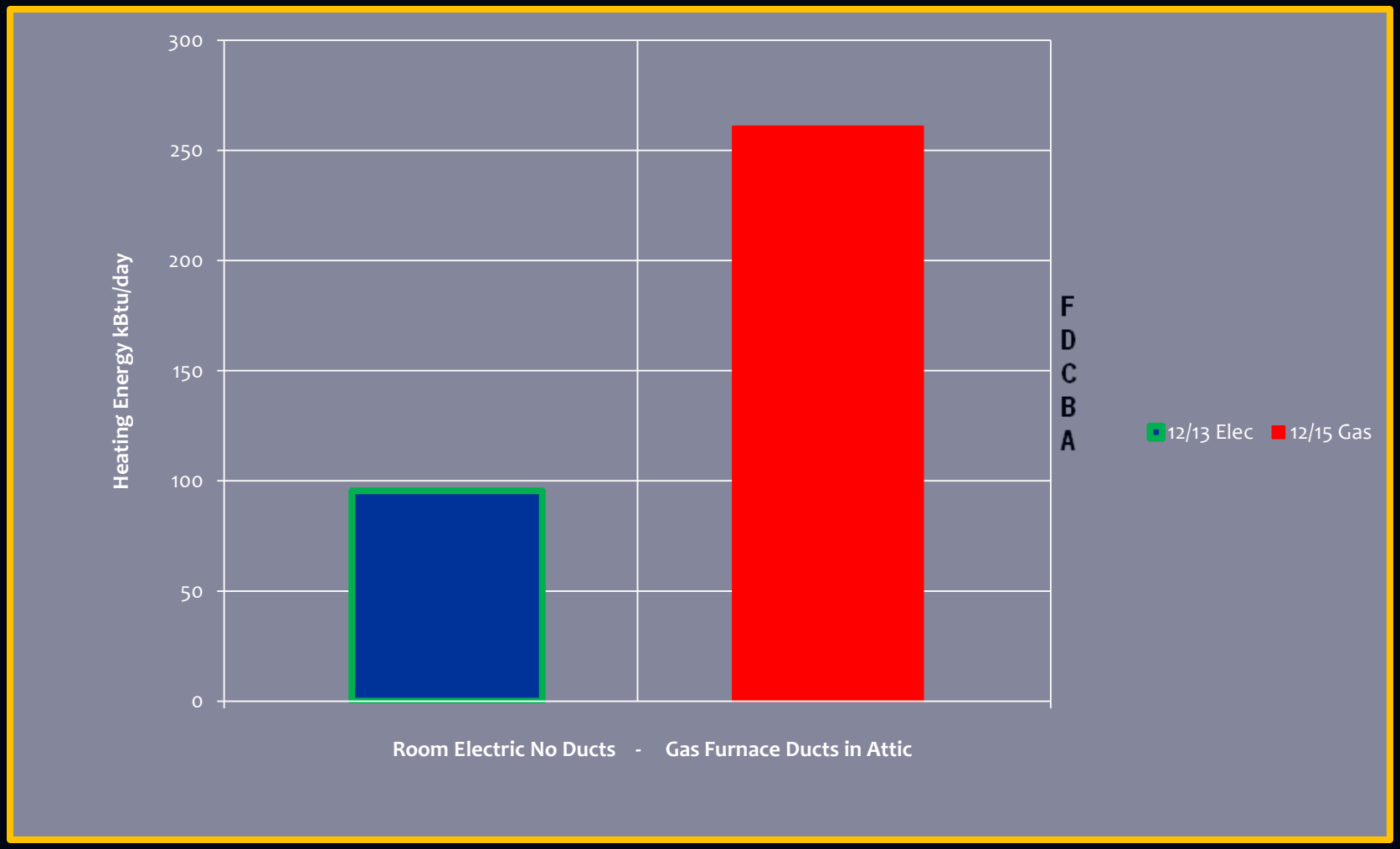
Source: California Energy Commission report 500-2012-062 and Rick Chitwood

AC Sensible Capacity



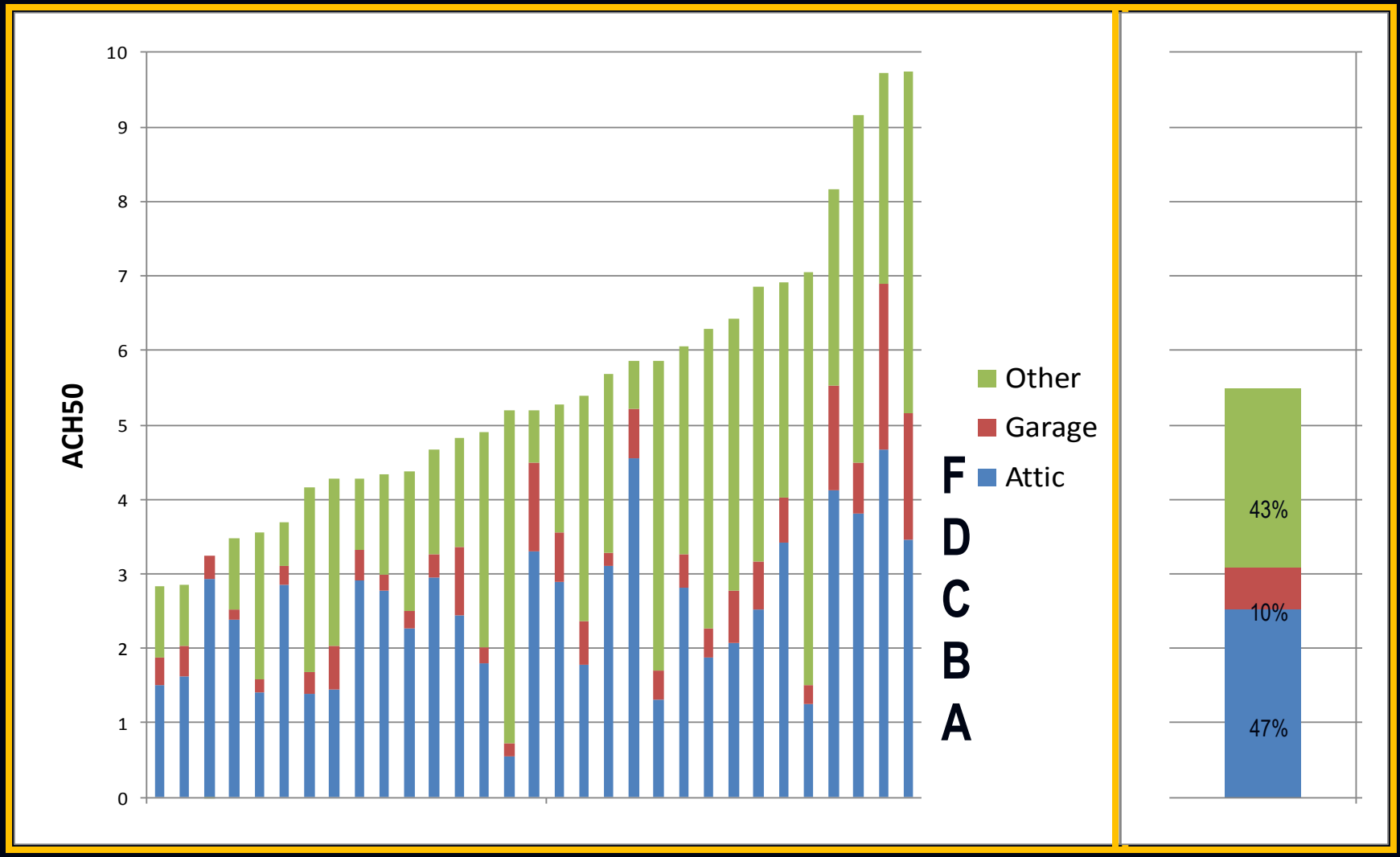
Source: California Energy Commission report 500-2012-062 , Rick Chitwood, and Energy Docs Home Performance

2005 Home – Heating Energy



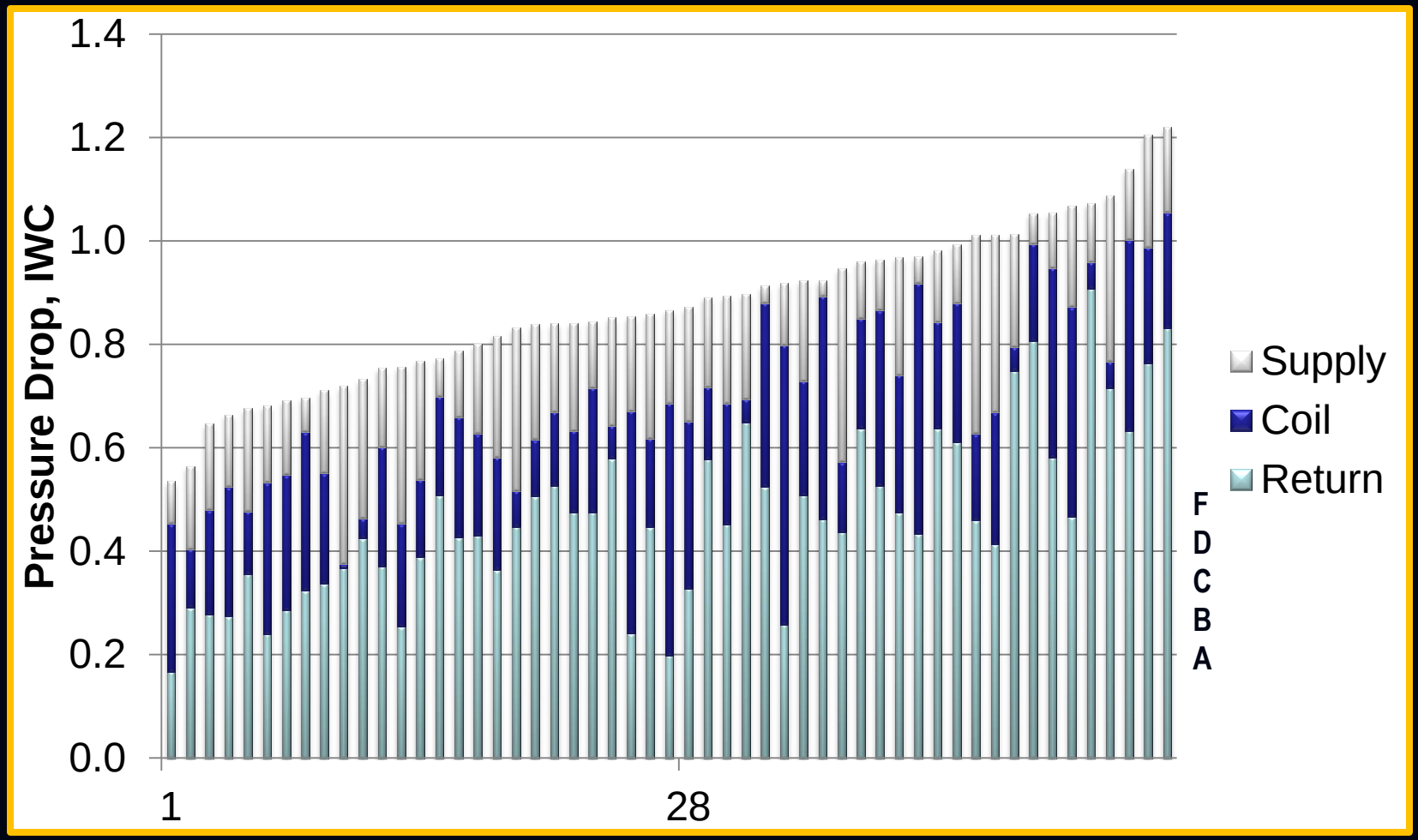
Source: California Energy Commission project Stockton Research Houses and Rick Chitwood

Air Leakage Rates and Path



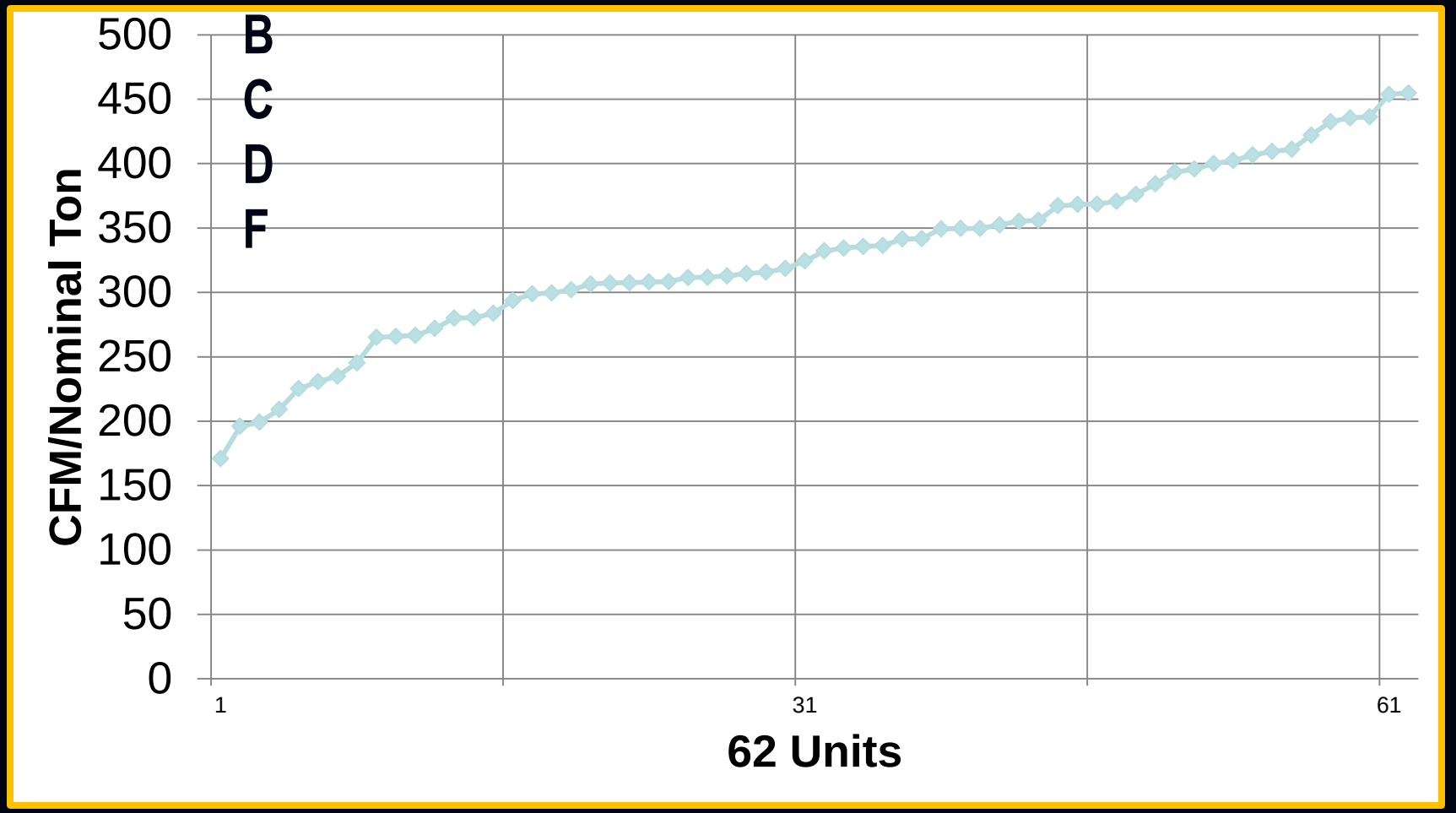
Source: California Energy Commission report 500-2012-062 and Rick Chitwood

Measured External Static Pressure



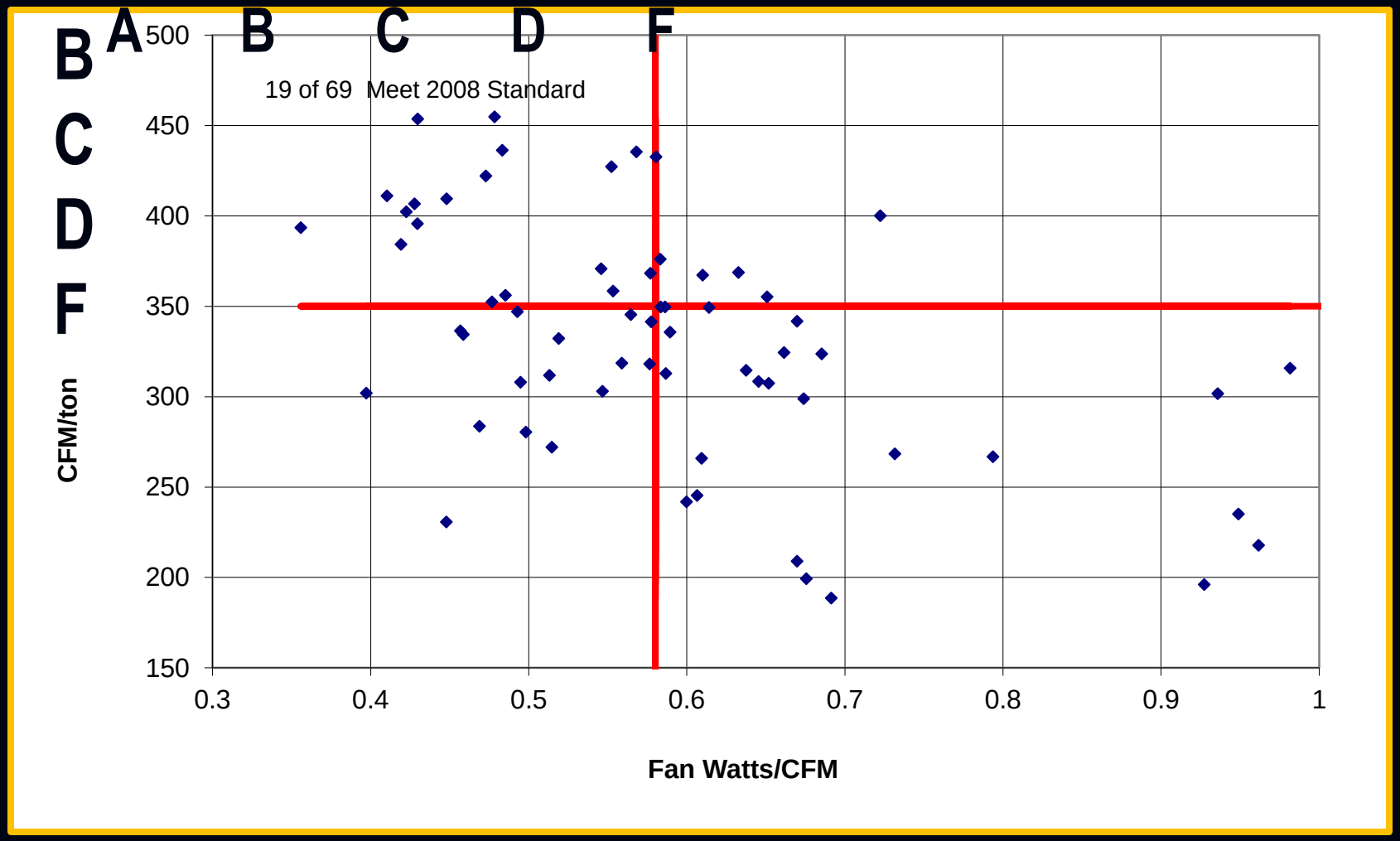
Source: California Energy Commission report 500-2012-062 and Rick Chitwood

Evaporator Coil Air Flow



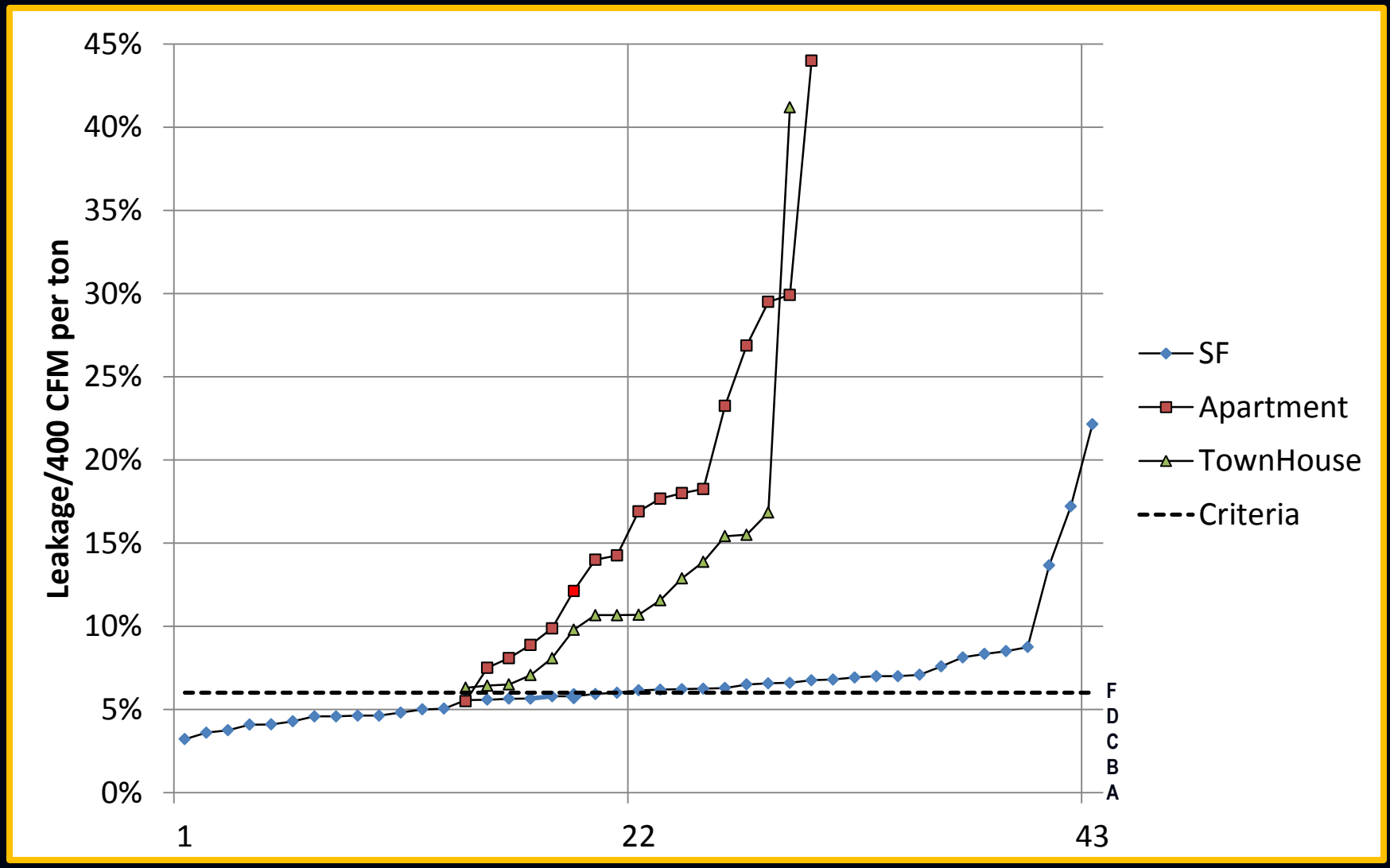
Source: California Energy Commission report 500-2012-062 and Rick Chitwood

Air Flow and Fan Watts



Source: California Energy Commission report 500-2012-062 and Rick Chitwood

Total Duct Leakage @ 25 Pa



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